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Limnological and Engineering Analysis of a Polluted Urban Lake

Prelude to Environmental Management of Onondaga Lake, New York

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TABLE 2.2. Summary of information relating to industrial groundwater contamination around the southern portion of Onondaga Lake.

Name/location	# Monitoring/ test borings/ piezometers	Type of conductivity test	Range in values for conductivity	Major contaminant/ $\bar{x}$ conc.	Primary discharge point	Source of information
†McKesson Corp. Bear street	22/36/13	Slug	10^{-5}–10^{-4} $cm \cdot s^{-1}$ 0.03–0.3 $ft \cdot d^{-1}$	hydrocarbons, methanol methylene chloride n,n-dimethylaniline	Barge Canal Onondaga Lake	Blasland and Bouck Engineers 1990
†Mobil Oil Bear/Solar Street	17/12/#	Slug	10^{-5}–10^{-3} $cm \cdot s^{-1}$ 0.03–3 $ft \cdot d^{-1}$	fuel oil, gasoline kerosene	Barge Canal	Empire Soils Investigations, Inc. 1990
†Marley Property W. Hiawatha Boulevard	25/#/#	Slug	10^{-4}–10^{-2} $cm \cdot s^{-1}$ 0.3–108 $ft \cdot d^{-1}$	fuel related compounds TPH* = 3–30 $mg \cdot L^{-1}$	Barge Canal	Dunn Geoscience Corp. 1988a
†Clark Property W. Hiawatha Boulevard	10/13/#	Slug	10^{-4}–10^{-2} $cm \cdot s^{-1}$ 0.3–15 $ft \cdot d^{-1}$	lubricating oil TPH = 0–15 $mg \cdot L^{-1}$ >200 ppm chlorinated/ halogenated hydrocarbons	Barge Canal	Dunn Geoscience Corp. 1988b
†Buckeye Property W. Hiawatha Boulevard	7/#/#	Slug	10^{-2} $cm \cdot s^{-1}$ 15 $ft \cdot d^{-1}$	lubricating oil TPH = 0–4.4 $mg \cdot L^{-1}$	Barge Canal	Dunn Geoscience Corp. 1988c
††Regional Market Park Street	7/24/#			refuse, CH_4, H_2S, TPH = ~1 $mg \cdot L^{-1}$ PCBs = <3 $\mu g \cdot L^{-1}$	Onondaga Lake Ley Creek (?)	Calocerinos & Spina Engineers 1988
††Crouse-Hinds Landfill 7th North Street	11/#/# (North landfill)		10^{-6}–10^{-3} $cm \cdot s^{-1}$ 0.02–7.7 $ft \cdot d^{-1}$	phenol, benzene, toluene xylene, cyanides	Ley Creek	Engineering Science, Inc. 1983
††GM-Fisher Guide Factory Avenue	14/23/#		10^{-6}–10^{-3} $cm \cdot s^{-1}$ 0.003–3 $ft \cdot d^{-1}$	PCBs = 0–180 ppm	Ley Creek Load ~0.15 $g \cdot d^{-1}$	O'Brien & Gere 1989a
†††Allied Chemical Willis Avenue	26/#/#	Pump (shallow aquifer)	10^{-6}–10^{-4} $cm \cdot s^{-1}$ 0.003–0.3 $ft \cdot d^{-1}$	halogenated hydrocarbons chlorinated hydrocarbons	Onondaga Lake Load ~46 $kg \cdot d^{-1}$	Groundwater Technology 1984b

*TPH = Total Petroleum Hydrocarbons.
† Oil City.
†† Ley Creek.
††† Allied.

TABLE 2.3. Partial listing of known organic pollutants in the Oil City area and their potential mobility class.

Compound	Mobility class*
Acetone	very high
Aniline	very high
Chloromethane	very high
Methylene chloride	very high
Phenol	very high
1,1 Dichlorothane	very high
Trans-1,2 Dichloroethene	very high
Benzene	high
Benzoic acid	high
Chorobenzene	moderate
Toluene	moderate
Trichloroethene	moderate
1,1,1 Trichloroethane	moderate
1,2 Dichlorobenzene	moderate
2-Butanone	moderate
Ethylbenzene	low
Naphthalene	low
2-Methylnaphthalene	slight

* Mobility rates are based on a low permeability glacial till with an organic carbon content of approximately 0.5% (modified from Fetter 1988).

organic pollutants found in groundwater samples taken from Oil City, along with an assigned potential mobility class based on flow through a low permeable glacial till. It should be kept in mind that the types and concentrations of contaminants are often site specific rather than dispersed throughout the entire area. The potential mobility rates given in Table 2.3 are examples of the potential mobility rates of contaminants under the general geologic composition of glacial till; the actual mobility rates of the contaminants will depend on the specific chemical, concentration, the sediment composition of the pathway, and whether the pathway includes sewer and utility pipelines.

Combined, Tables 2.2 and 2.3 indicate the potential for moderate-to-rapid transport of fuel-related compounds and synthetic organic chemicals to adjacent surface waters. At one site, initial chemical analysis confirmed the migration of hydrocarbon contamination toward the Barge Canal (Empire Soils Investigations, Inc. 1990). Additional investigation resulted in observations of a "sheen" on the water seeping into five test pits dug near the Barge Canal. Analytical results indicated groundwater samples collected within 60 ft of the Barge Canal had total petroleum hydrocarbon (TPH) concentrations of $>200{,}000\,\mu g \cdot L^{-1}$ (one sample had a TPH concentration of $2{,}300{,}000\,\mu g \cdot L^{-1}$).

Based on the information available, it is reasonable to conclude that the Oil City area is a potential source of chemical contamination to Onondaga Lake via groundwater transport. Although it presently cannot be determined what the exact pathways of transport are, whether patterns of contaminants exist, and at what rates the contaminants move, there is enough evidence to warrant a more intensive compilation of the data and to continue further investigations of this area.

2.2.2 Ley Creek

Located within Ley Creek's drainage basin are a number of large industrial and commercial complexes and several landfills. Available information includes descriptions of geologic conditions, types of contaminants, and directions of groundwater flow. Hydrogeologic assessments of several locations indicate a range of contamination that includes PCBs, benzene, toluene, xylenes, phenols, municipal refuse, and gas (CH_4 and H_2S) accumulations in and around landfill sites (Engineering-Science, Inc. 1983; Calocerinos and Spina Engineers 1988; O'Brien and Gere Engineers 1989a). The following is a summary of several hydrologic investigations undertaken along Ley Creek.

2.2.2.1 Geology of Selected Areas Along Ley Creek

Subsurface investigations at several sites along Ley Creek (Figure 2.15a) reveal a varied subsurface stratigraphy (O'Brien and Gere Engineers 1989a; Calocerinos and Spina Engineers 1988; Engineering Science, Inc. 1983). Approximately 3.8 mi (6 km) upstream from Onondaga Lake, driller's well logs show up to 35 ft (11 m) of dredged fill material (fine grain fluvial and lacustrine deposits, silts and

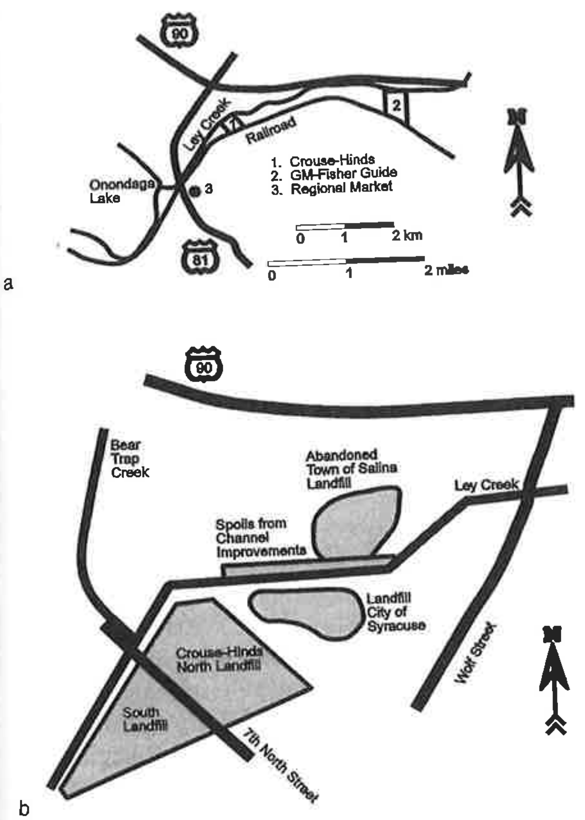

FIGURE 2.15. (**a**) Locations of major hydrogeologic investigations in the Ley Creek watershed. (**b**) Locations of known landfills in the Ley Creek watershed that are near Onondaga Lake (modified from Engineering Science, Inc. 1983).

clays) underlain by a dense red-brown clay containing silt, sand and embedded gravel fragments (O'Brien and Gere Engineers 1989a). Approximately 1.1 mi (1.8 km) upstream of Onondaga Lake, the stratigraphic column shows 15 ft (5 m) of fill material (foundry sands, municipal, wastes, and wood) underlain by 5 ft (1.5 m) of a high-conductivity peat (2.7×10^{-3} cm $\cdot$ s^{-1}; 7.7 ft $\cdot$ d^{-1}) and 30 ft (9 m) of sand and silt. At the base of the sand and silt unit is approximately 50 ft (15 m) of sand and gravel underlain by bedrock (Vernon shale) at an approximate depth of 100 ft (31 m) (Engineering Science, Inc. 1983). Approximately 2,000 ft (0.6 km) northeast of Onondaga Lake, the surficial materials consist of 8 ft (2 m) of fill (cinders, silt, fine-to-coarse sand, fine-to-medium gravel, wood, and rubble), underlain by 12 ft (4 m) of a gray, wet, soft marl with some sand and peat. At a depth of approximately 20 ft (6 m), 5 ft (1.5 m) of marl grading to silt occurrs and is underlain by over 60 ft (19 m) of silt grading to sand and sand grading to fine gravel (Calorcerinos and Spina Engineers 1988). It is probable that the bedrock underlying the sand and gravel is Vernon shale; it likely occurs at a depth of approximately 100 ft (30 m).

2.2.2.2 Hydrogeology of Selected Areas Along Ley Creek

Much of the land adjacent to Ley Creek from the south branch headwaters downstream to its outlet was originally marsh that was subsequently reclaimed for landfill areas and industrial parks. Reclamation was usually accomplished by filling in the wetland areas with municipal and industrial solid wastes, along with common construction debris. Table 2.2 (refer to Section 2.2.1.3.2) includes information regarding hydraulic conductivities and major contaminants cited from the various hydrogeologic assessments along Ley Creek. The following material is a summary of the available information regarding the locations of contaminated landfills, and one area known to be contaminated with PCBs.

General Motors-Inland Fisher Guide Division is located along Ley Creek and Factory Ave (Figure 2.15a). Soils on the site, along with portions of Ley Creek, are known to be contaminated with PCBs as a result of the disposal and dredging of materials used in hydraulic die casting operations at the Inland Fisher Guide Facility (IFG) (O'Brien and Gere Engineers 1989a). Table 2.4 summarizes the degree of PCB contamination at the site. The mean concentration of PCB's in the ground water at the IFG site is 3.62 μg $\cdot$ L^{-1}. Mass transport of PCB's from the ground water into Ley Creek is estimated to be 0.15 gm $\cdot$ d^{-1}.

Landfills located near the outlet of Ley Creek are listed in Table 2.5 and their locations are shown in Figure 2.15b. The most complete set of information relates to the

TABLE 2.4. Summary of suspected PCB contamination at the IFG site.

Sample type	Concentration of PCBs
On-site soils	ND*-180 ppm
Ley Creek sediments	ND-8.3 $mg \cdot kg^{-1}$
Groundwater samples†	ND-21 $\mu g \cdot L^{-1}$
Stream water samples	ND-1.4 $\mu g \cdot L^{-1}$
Air samples	<0.001 $mg \cdot m^{-3}$

Modified from O'Brien and Gere Engineers 1989a.
*ND indicates that a value was below the detection limit.
†NYS Class GA groundwater standard for PCBs = 0.01 $\mu g \cdot L^{-1}$.

Crouse-Hinds Landfill. Two aquifers are located beneath the Crouse-Hinds Landfill; a shallow aquifer composed of peat and located within and directly beneath the fill material at depths of 4 to 8 ft (1.2 to 2.4 m), and a lower aquifer composed of deep sands and gravels (Engineering Science, Inc. 1983; Thomsen Associates 1983). The two aquifers are separated by 12 to 32 ft (3.7 to 9.8 m) of silt and clay (Thomsen Associates 1983). The water table is 4.5 to 6 ft (1.4 to 1.8 m) below the land surface and the surface of the shallow aquifer is at the same depth (Engineering-Science, Inc. 1983). Groundwater flows toward Ley Creek, located 581 ft (170 m) west of the site, at an average rate of 6 $ft \cdot yr^{-1}$.

A summary of the groundwater chemistry from the Crouse-Hinds north landfill is given in Table 2.6. High TDS concentrations in the leachate (due primarily to calcium, sodium, and potassium) have been attributed to municipal wastes (Engineering Science, Inc. 1983). Due to the shallow screening of the monitoring wells, much of the shallow aquifer was not sampled and groundwater contamination may be worse than initially suspected (Table 2.6; Engineering Science, Inc. 1983). It is also unknown whether the lower sand and gravel aquifer is hydrologically connected to Ley Creek and whether this lower aquifer has been contaminated (Engineering Science, Inc. 1983).

2.2.3 Ninemile Creek

Originating from Otisco Lake, Ninemile Creek flows north over the Appalachian Uplands and down the Helderberg Escarpment near Marcellus. It then flows onto the lake plain, finally entering Onondaga Lake near Lakeland. Ninemile Creek presently contributes over 50% of the surface water chloride load to Onondaga Lake (Auer et al. 1991). Surface and groundwaters north of Warners-Amboy have high ionic concentrations (Kantrowitz 1970; Winkley 1989; Noble 1990). An im-

TABLE 2.5. Landfills located near the outlet of Ley Creek.

Landfill/location	Size	Dates of operation	Type of contaminant	Source
Crouse-Hinds Landfill 7th North Street	North: 22 acres	1950–?	Primarily inorganic materials Also fly-ash, zinc hydroxide, and foundry sands, phenols, benzenes and toluene	1
	South: 21 acres	1960–1969	Unknown quantities of inorganic and organic materials	
Regional Market Park Street		1946–present	Up to 16 ft of miscellaneous fill, trash, CH_4, H_2S PCBs: <3$\mu g \cdot L^{-1}$	2
Salina Landfill Wolf Street/Thruway	100 acres		Municipal waste with some PCBs: concentrations range from nondetectable to 270 ppm Also semivolatile and volatile organics and heavy metals	3
Syracuse Landfill Wolf Street		1960–1964	Unknown quantities of municipal wastes construction demolition materials and garbage	1

1. Engineering Science, Inc. 1983; 2. Calocerinos & Spina Engineers 1988; 3. NYSDEC, personal communication.